F Appendix F: A Hypothetical Watershed Perspective on Offsetting Nutrient Load Increases

This example is for illustrative purposes to support informed dialogue on the subject of offsetting pollutant load increases. Neither the general approach nor the specifics represent State policy.

The setting is a watershed of about 25,500 acres with land uses shown in Table 1 below. A TMDL has been established, which is summarized as part of the "Summary of Initial Considerations" below. This case has been intentionally created to be challenging. There are two municipal point sources, and two permitted industrial point sources; however, the larger industrial source has announced that it will be ceasing operations within the year. Several subdivision development projects are pending, and additional land has been zoned for future development.

Table 1
Baseline Nonpoint Source Conditions for Hypothetical Watershed

Land Use	Land Use Acres	TN Loading Rate lbs/ac/yr	TN Load lbs/yr
Mixed Agriculture	12,892	15.3	196,937
Atm Dep to water	1,736	9.6	16,663
Forest	9,078	1.2	10,893
Open Urban	255	4.5	1,138
Urban on Septic	2,537	14.7	37,344
Urban on sewer	779	7.5	5,846
	25,541		268,821

Summary of Initial Considerations

- Small Municipal WWTP
  (Design flow capacity of 88,000 gallons per day, 18 mg/l, Allocation of 4,822 lbs/yr)
- Large Municipal WWTP
  (design flow capacity of 3.0 million gallons per day, 8 mg/l, Allocation of 73,060 lbs/yr)
- Small Industrial WWTP
  (flow of 8,000 gallons per day, 18 mg/l, Allocation of 438 TN lbs/yr)
- Large Industrial WWTP
  (flow of 0.247 million gallons per day, 18 mg/l, Allocation of 13,530 TN lbs/yr, ceasing operations within the year)
- Zoning and pending subdivisions, consisting of 800 acres of forest, and 200 acres of crop land, are planned for development over a future time horizon.
  - About 70% will be on public sewer for which there is sufficient capacity at the large WWTP. The land has potential for about 1,300 equivalent dwelling units (EDUs).
  - About 10% is currently planned to use onsite sewage disposal systems.

– About 20%, located near the small WWTP, has a 450 (EDU) potential; however, the small plant flow capacity would need to be doubled (or more if current inflow and infiltration (I&I) problems are not resolved).

- **TMDL* (TN) = Point Source Allocations + Nonpoint Source Allocations**
  212,819 lbs/yr= 91,850 + 120,969
  * To simplify this example, this number is actually the TMDL minus the margin of safety.
- Current NPS baseline load: 268,821 lbs/yr (TN) implies that a 55% Reduction needed.
- Point sources are currently within their allocations; however, it will be shown that part of the point source load will need to be reallocated to meet the nonpoint source load, and offsets will be needed to support the addition growth reflected by zoning and pending subdivisions.

A watershed-wide planning level analysis suggests possible steps for reducing nitrogen to achieve the TMDL, and offsetting proposed increases in nitrogen to ensure that the proposed development is consistent with maintaining the TMDL. To simplify the presentation, the analysis is divided into two parts. For the first part, recall the current point source loads are consistent with the waste load allocations for point sources in the TMDL. Hence, the first part focuses on taking steps to achieve consistency of the nonpoint sources with the TMDL. This will be done in part by reallocating some of the point source WLA to the nonpoint source LA.

The second part of the analysis focuses on meeting the needs of the proposed development near the small WWTP, which will need to expand to accommodate the new development. A range of options is proposed that would enable consistency with the TMDL. The ultimate choice would depend on cost estimates and other practical factors that are beyond the scope of this hypothetical case. One of these factors is the potential that elements of the first part of the analysis might provide other options to consider in the second part.

First Part of Analysis: Nonpoint Source Consistency with TMDL

Below is a listing of the steps in the first part of the analysis. It makes use of NPS reductions and reallocations from point sources to nonpoint sources, resulting in a broad plan that is consistent with the TMDL.

A. Update the land cover to reflect the conversion of forestland and cropland to developed land accounting for 10% of that land being on septic systems. Compute the nonpoint source loads by using the Chesapeake Bay Program loading rates under the assumption that the Tributary Strategies have been fully implemented in this watershed. The results are summarized in Table 2.

   RESULT: The NPS load is reduced 25% from 268,821 lbs/yr to 172,307 lbs/yr. A 30% reduction remains necessary to achieve the NPS LA of 120,969 lbs/yr.

Table 2
Nonpoint Source Conditions for a Hypothetical Watershed Including Tributary Strategy Implementation and Changes in Land Use to Reflect Proposed Development

Land Use	Projected Land Use Acres	TN Loading Rate[a] lbs/ac/yr	TN Load lbs/yr
Mixed Agriculture	12,693	9.0	113,800
Atm Dep to water	1,736	7.9	13,787
Forest	8,277	1.2	9,655
Open Urban	255	3.3	847
Urban on Septic	2,636	9.4	24,778
Urban on Sewer	1,680	5.6	9,439
	25,541		172,307

a. Loading Rates assuming the Tributary Strategy is fully implemented.

It appears infeasible to achieve the NPS reduction given that the Tributary Strategy is considered to be very ambitious. Attention is turned to options for redistributing some of the excess point source waste load allocation to the NPS allocation category.

B. The TMDL analysis assumed an 8 mg/l nitrogen concentration at the large WWTP, which has a design flow of 3.0 million gallons per day (MGD). The Tributary Strategy includes a policy to upgrade major plants to ENR, which are predicted to operate at 4 mg/l. The difference in point source load associated with this upgrade (36,530 lbs/yr) can be reallocated from the point source WLA to the nonpoint source LA in the TMDL. The calculation is shown below:

Current WLA: 3.0 MGD x **8 mg/l** x 8.34 (conversion) x 365 days/yr = 73,060 lbs/yr
ENR WLA: 3.0 MGD x **4 mg/l** x 8.34 (conversion) x 365 days/yr = 36,530 lbs/yr
Difference: 73,060 lbs/y – 36,530 lbs/yr = 36,530 lbs/yr

RESULT: The TMDL equation changes as the NPS and PS allocations are shifted:
TMDL* (TN) = Point Source Allocations + Nonpoint Source Allocations
Original: 212,819 lbs/yr =91,850 + 120,969
Revised: 212,819 lbs/yr =55,320 + 157,499

Based on NPS reductions in Step A, the projected nonpoint source load shown in Table 4.1 remains at 172,307 lbs/yr, which is still in excess of the new more generous NPS allocation of 157,498 lbs/yr shown in the revised TMDL immediately above.

C. Knowing that the large industrial firm is planning to cease operation, the allocation from that source of 13,530 lbs/yr will become available for redistribution to the NPS allocation category.

RESULT: The TMDL equation changes as the NPS and PS allocations are shifted:

TMDL* (TN)	= Point Source Allocations	+	Nonpoint Source Allocations
Previous: 212,819 lbs/yr =	**55,320**	**+**	**157,499**
Revised: 212,819 lbs/yr =	**41,790**	**+**	**171,029**

The revised allocation of 171,129 lbs/yr is nearly sufficient to cover the projected NPS load of 172,307 lbs/yr. At this point, alternative NPS reductions are considered for closing the remaining gap by reducing the projected 172,307 lbs/yr down to 171,129 lbs/yr.

D (Option 1) Reforestation or wetlands creation of about 165 acres of cropland is estimated to achieve the necessary reduction. The 165 acres represents slightly more than 1% of the remaining 12,693 acres of cropland after cropland acreage reductions associated with development projections have been accounted for. It would be appropriate for the costs of reclaiming the 165 acres to be borne by developers who benefit from the associated offset. Administering such offsets could be affected by transfer of development rights, by transactions with land trust organizations, or by local government administered forest/wetlands banks.

Optionally, part or all of the projected 165 acres could be accommodated in advance through a combination of options for refining the land use plan in this watershed (a little down zoning, special forest conservation requirements in some areas (e.g., clustering, forest preservation ratios, etc.), shifting the proportion of forest and crop lands that are identified for intense development. Advanced planning would have the benefits associated with addressing the TMDL issues up front, rather than as part of an offset requirement for developers. These benefits include more certainty in the outcome, less time expended by government and developer staff to negotiate offsets, less administrative burden (time and cost) associated with identifying and executing the offset (this has a long-term compliance element to consider), less cost to the developer who would likely have to fund the offset, which might include financial commitments associated with bonding the forest/wetlands mitigation process.

(Option 2) The connection of septic systems to public sewer could also be considered to close this gap, in part or in whole; however, the accounting would have to consider that a septic system reduction has already been credited as part of the assumed implementation of the Tributary Strategies in Step A.

RESULT: The TMDL is projected to be achieved. A reallocation, subject to public review, would produce a result as shown in the revised TMDL under Step C, above.

The four previous scenarios are summarized in Table 3 below.

Table 3
Summary of a Hypothetical Watershed Analysis to Outline a Plan for Nonpoint Source Consistency with the Nitrogen TMDL

Loading Scenario	NPS Load lbs/year	NPS Allocation lbs/year	PS Allocation lbs/year	TMDL* Allocation lbs/year	Percentage of NPS Reduction Needed
Current NPS Baseline	**268,821**	**120,969**	**91,850**	**212,819**	**55.0**
A. Tributary Strategy NPS Loads & Land Use Changes	172,307	120,969	91,850	212,819	29.8
B. Trib Strategy NPS & 4mg/l at Large WWTP	172,307	157,499	55,320	212,819	8.6
C. Trib Strategy NPS & 4 mg/l & transfer of industrial load to NPS	172,307	171,029	41,790	212,819	0.7
D. Trib Strategy NPS & 4 mg/l & transfer of industrial load to NPS & Reforestation	171,020	171,029	41,790	212,819	0.0

* Note the margin of safety has been subtracted from the TMDL.

<u>Second Part of Analysis: Offsetting Point Source Load Increases at the Small WWTP</u>

Due to projected growth in the village serviced by the small WWTP, the need for waste treatment is projected to about double. The current WWTP has effectively reached capacity, in part due to an aged sewer collection system that experiences significant inflow and infiltration (I&I) during wet weather conditions.

Table 4 summarizes some supporting information for the analysis. Supporting Element 1 is the current design capacity of the small WWTP. The design flow is 88,000 gpd, which on average should service 350 equivalent dwelling units (EDU) at 250 gpd per EDU. The point source allocation in the TMDL is sufficiently large to accommodate the projected load of 4,822 lbs/yr; however, due to the I&I, the plant flow reaches capacity during wet weather conditions. The load estimate assumes an effluent concentration of 18 mg/l, which is the norm for small plants that do not use biological nutrient reduction (BNR) technology[26].

Table 4
Supporting Information for Analysis to Offset Nitrogen Load Increases for Development Near the Small WWTP

Supporting Information Elements	Waste Flow (gallons/day)	Effective Dwelling Units[a]	TN Load (lbs/year)
1. WWTP Design Capacity	88,000	350	4,822
2. Current WWTP Status	87,500	250[b]	4,794
3. Proposed Incremental Increase	112,500	450	6,164
D. Proposed Totals	200,500	650 –750[c]	10,984[d]

a. Each EDU is estimated to generate an average of 250 gallons of waste flow per day.
b. I&I results in an effective flow per EDU of about 350 gallons per day (29% over the norm of 250 gpd). This results in a lost plant capacity of 25,000 gpd, or about 100 EDUs in development potential.
c. Only 650 EDUs would be available under the current proposal if the I&I problem is not mitigated.
d. Given that the current load (4,794 lbs/yr) nearly reaches the waste load allocation (4,822 lbs/yr), nearly all of the proposed increase in load (6,164 lbs/yr) would need to be offset.

Element 2 shows the current status of the small WWTP. Due to I&I, the plant capacity is not being used efficiently. Flow to the plant during wet weather (87,500 gpd) nearly reaches capacity (88,000 gpd). As a result, only 250 EDUs, of the 350 EDU design potential, can currently be serviced by the plant. This results in a lost development potential of about 100 EDUs. The current annual nitrogen load of 4,794 lbs/yr nearly reaches the waste load allocation cap of 4,822 lbs/yr.

Element 3 shows the incremental increases associated with development potential reflected in the local land use plans. Waste flow is projected to increase by 112,500 gpd in order to support about 450 planned EDUs. If treated at a larger WWTP of similar treatment technology (effluent concentration of 18 mg/l) this projected development would generate 6,164 lbs/yr beyond the allocation of 4,822 lbs/yr reflected in the current NPDES permit.

Below is a list of offset considerations. They are presented independently; however, the ultimate outcome would most likely consist of a combination of these considerations, and possibly others. The final outcome might also involve reconsideration of the First Part of the analysis, presented above.

A. I&I Mitigation[27] could reclaim WWTP flow capacity to accommodate as much as 100 EDUs of the 450 proposed by land use planning (partial mitigation is also an option). In addition to

[26] BNR technology, adopted in the 1995 Tributary Strategies, achieves an effluent concentration of about 8 mg/l. ENR technology (Enhanced Nitrogen Removal) treats to about 4 mg/l, and is being adopted in the current Tributary Strategies.

[27] Inflow and infiltration (I&I) of subsurface water into cracks in the sewage collection system can significantly increase the volume of water received by the plant during wet weather conditions. This uses up the available tank

accommodating new development, this would help to offset about 1,540 lbs of the 6,164 lbs/yr projected increase in nitrogen. Due to the cost and disruption of I&I repairs, the jurisdiction is considering the establishment of an impact fee on all future development in this sewer district to create an investment fund envisioned to support longer-term development potential beyond the 450 EDUs presently envisioned in the land use plan.

B. Spray Irrigation could be considered for all or part of the effluent. It would be necessary to expand the WWTP flow capacity. If sufficient spray field acreage can be located to receive the additional 112,500 gpd, it might be possible to offset the increased nitrogen without investing in additional treatment technology. Funding from developers to cover the WWTP flow expansion and spray irrigation capital costs could be justified to cover the cost of offsetting increased nutrient loads necessary to accommodate the new development.

   Even if alternative options to spray irrigation are chosen at this time, the local jurisdiction might consider establishing an impact fee on new development for the purchase or creation of easements to maintain the option of future spray irrigation. This fee would be justified on the basis of ensuring long-term development potential, beyond the envisioned 450 EDUs, which is in the interest of the development community.

C. Upgrading the WWTP to BNR might prove to be a more cost-effective alternative than the use of spray irrigation at the present time. Treating the total projected flow of 200,500 gpd (88,000 + 112,500) to 8 mg/l would result in an annual load of 4,883 lbs/yr, which happens to compare favorably with the current allocation of 4,822 lbs/yr.

D. A short-term transfer of load allocation from the WLA for the large WWTP to the small WWTP is another option to consider. In other words, because the large WWTP is not currently discharging its total allowable waste load allocation, part of the unused portion could be transferred to the small WWTP as a temporary accounting of loads. This could enable cost savings in the near term (e.g., delaying the cost of investing in spray irrigation or a treatment upgrade at the small WWTP). NOTE: If the two plants are operated by separate entities, an additional administrative process would be necessary.

   In order for a short-term transfer of the accounting to be acceptable, a solid plan would likely be necessary to show that offsets at the small WWTP were certain to be executed at a future date when the large WWTP needs to reclaim the transferred allocations. If future offsets at the small WWTP did not come to fruition, it would prevent a reallocation of loading credits back to the large WWTP from the small WWTP. This might result in an effective cap on using the full flow capacity of the large WWTP. This could have serious implications if the financing for the capital costs of building the large plant depends on a funding stream from utility fees from future development, which in turn depends on using the full design capacity of the plant.

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volume at the treatment plant, reducing the amount of sewage the plant can accept. This translates into a reduction in the number of development units that can be serviced by the plant. Mitigation involves fixing the cracks or replacing pipes.